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Harvey and the Chemical Industry

Hurricane Harvey, a category 3 storm ravaged the greater Houston area and other cities along the U.S. gulf coast. According to some reports, the storm was responsible for a 500-year flood, which caused very high water levels rising very rapidly in many areas. The storm itself was the direct cause of more than 60 fatalities, many more injuries, and untold other human sufferings. Reports have categorized this storm and its outcome as the costliest one in U.S. history with damage and rebuilding estimates being higher than 100 billion dollars.

The storm also battered the chemical and oil and gas industry very extensively. The approaching storm and the storm itself caused the whole industry all along the gulf coast to come to a grinding halt, shutdown and stoppage of production. Chemical plants are designed to withstand all kinds of scenarios including hurricane-force winds and floods; however, the severity of Harvey (characterized by some as a 500-year event) has thrust the industry into uncharted territory. The combination of Harvey's path, duration and rainfall total has led to several hazardous materials incidents (including the Arkema incident in Crosby, Texas). Needless to say, the storm and the associated shutdowns have also caused havoc with the supply side of the U.S. chemicals industry on an unprecedented scale. The extent of process safety consequences in different plants includes minor upsets, extensive flaring, unplanned releases of chemicals to avoid other undesirable outcomes, and the Arkema incident. While the damage caused by Harvey and the ensuing chemical plant incidents are and should be a cause for concern, we should look at things in the right perspective. Given the severity and rare probability of Harvey, if the totality of consequences we end up dealing with from industry events are limited to what we have seen so far, I would say that investments made in the process safety programs served their purpose.

Regardless of the perspectives (ranging from trivial to dire) regarding the consequences from the Harvey-related incidents, it must be recognized that we are not out of the woods yet. A lot of work needs to be done to assess any potential damage to the equipment, tankage, and other process facilities by the storm and the flood. Startup and shutdown under normal circumstances are transitional processes with inherent dangers and the potential for undesirable outcomes and incidents is relatively higher compared to steady-state operations. Thus, startups of all the gulf coast plants following the receding impact of Harvey is at best going to be a challenging task and at worst could result in potential incidents because of compromised and damaged equipment.

For the Arkema event, the consequences range from the fume/flame exposure that we saw for some of the emergency responders to explosions (most likely not as large as West, and most likely the impacts would have been contained within the 1.5 mile radius). There could also be some toxic releases that may have some health effects, but again we have to assume that the 1.5 mile radius was chosen with some basis that the dispersion will bring the concentration below dangerous levels.

Effective safety programs are usually designed with what might be referred to as the PMR concept. PMR refers to a hierarchical approach consisting of prevention, mitigation, and response systems. It is apparent why a hierarchical approach is used

because, if at all possible, the first option is to prevent the undesirable outcome from occurring. If prevention does not work to the fullest extent, then the mitigation systems are available to reduce the impact zone. Finally, the response mechanisms are set up to reduce the consequences, terminate the event, and save people and property. Clearly some parts of the prevention and mitigation programs did not work in Arkema, only time will tell after detailed investigation reports are available with regard to what systems Arkema had in place with regard to prevention and mitigation and how well they worked. However, things worked much better with regard to the response and in general, I think the actions taken were appropriate. There seemed to be a high degree of coordination between Arkema, local response agencies, and other governmental agencies. When Arkema determined that they were not able to maintain refrigeration for the organic peroxides, they pretty much knew that it was only a matter of time that the material would progress into a runaway reaction and fires and explosions were likely. Thus, the decision to evacuate and maintain an exclusion zone was the appropriate action to take under the circumstances. I have to believe, without direct knowledge currently, that the 1.5 mile radius exclusion zone was determined on the basis of some explosion and dispersion calculations. In such situations, it is prudent to pick exclusion distances on a conservative basis.

In addition to the Arkema site, there are many other high hazard sites in the Greater Houston area that were impacted by hurricane Harvey and the ensuing floods. While there were other sporadic incidents and spills in a few other facilities, none caused as much concern as the Arkema facility. While the immediate emergency related to Harvey is behind us now, the whole petrochemical industry in the gulf coast is still dealing with the aftermath. Refineries are bouncing back from Harvey, which caused about 25% of U.S. refining capacity to shut down. Other chemical complexes are also assessing their facilities and undertaking the painstaking process of restarting. Getting these production facilities back on-line is a very complex problem. In addition to making sure that all employees are available and not personally impacted by Harvey, there is a need for a large number of additional specialized manpower to inspect the facilities and then startup. Startups require special procedures and represent proportionally larger number of incidents under normal circumstances. In the post-Harvey startups, additional care and inspections are needed to make sure that equipment or storage that may have been compromised by Harvey does not result in undesirable outcomes.

Arkema should have expected flooding as a scenario and loss of all power and refrigeration capability. However, some may say that it is not realistic for company officials to foresee such extreme flooding and such rapid increase of water levels. It would be revealing to find out if this facility has approached this point of flooding in the past. The dangers of the chemicals they produce should have prompted them to plan for the worst. They knew they were dealing with an unstable chemical that they needed to keep refrigerated. It must have been a tough decision to have to abandon the site knowing that refrigeration had failed for these unstable materials and there was potential for explosions and fires with ensuing consequences. They most likely needed another layer of protection for this extreme scenario. The smoke and combustion products (regardless of their hazard potential) will be perceived by many in the surrounding neighborhood to be harmful. We hope that the investigation launched by the U.S. Chemical Safety and Hazard Investigation Board results in a thorough, objective and credible report that answers some of these questions and provides lessons learned. The lessons learned should then be captured into the design and operations of the process facilities. Finally, while it is essential to discuss the sequence of events in the Arkema incident, it is even more important that we have a dialogue about what worked well and what did not work so that we can improve prevention, mitigation, response and recovery measures industry-wide. These lessons learned should be implemented as soon as possible because extreme weather events are becoming more and more common, and as such we must be prepared to deal with natural disasters triggering technological failures.

Also, the experience with Harvey as well as the experiences with West and Tianjin have taught us that it is very important to have knowledge about the hazardous materials that are present in our communities. Not only that, we also should be comfortable with the knowledge that we have the right programs in place to store and process those material safely.

Quite often, the terms hazard and risk are used interchangeably. That is wrong. The same inherent property that makes a substance hazardous also is the property that makes it useful. We have no choice but to accept some hazards in our midst (*e.g.*, a knife in the kitchen, gasoline for cars), but that does not mean we have to accept an unreasonable risk. The dialogue needs to focus on how we can manage the risk to an acceptable level but still get the benefits associated with the material/process.

There is one sharp contrast between the West and Arkema incident. Most likely because of the coordination with emergency responders, the consequences in the Arkema incident were contained and loss of lives was avoided.

The whole experience with Harvey has again put issues regarding land-use planning front and center. We need to have a national dialogue and develop some consensus with regard to location of sites near sensitive population zones. Currently, we do not have any requirements either at the federal level or local level to lay out guidelines and enforce those guidelines with regard to location of sites near sensitive population zones or high density areas. By the same token, in as much as possible, we must also select the locations of hazardous materials sites away from areas that are prone to extreme weather.

We must have a national tracking system (database) for hazardous materials incident surveillance. There is presently no reliable means for evaluating the performance of industry in limiting the number and severity of accidental chemical releases. There is also limited data with which to prioritize efforts to reduce the risks associated with such releases. Without this information, there are no means to measure the effectiveness of present programs or to guide future efforts. An incident surveillance system could also be used to improve planning, response capability, and infrastructure changes.

Sincerely,
The Mary Kay O'Connor Process Safety Center
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Mission:
Lead the integration of process safety - through education, research, and service - into the education and practice of all individuals and organizations involved in chemical operations.